CLAIMS

What is claimed is:

1. A crosslinked rubber latex composition comprising:

a polymer containing units having at least one of carboxyl and hydroxyl functional groups;

a coreactant polyelectrolyte having a relatively low molecular weight compared to the polymer, and compounded with the polymer to form a compound, and containing units having at least one of carboxyl and hydroxyl functional groups; and

a polyfunctional crosslinking agent timely added to the compound, and capable of crosslinking with at least two of the carboxyl or hydroxyl functional groups, or at least one of the carboxyl functional groups and at least one of the hydroxyl functional groups at ambient temperature or higher, thereby forming a crosslinked network in the rubber latex.

2. The composition of claim 1 wherein the polymer is in the form of a solution, latex, or dispersion.

3. The composition of claim 1 wherein the polymer and the coreactant polyelectrolyte are each in liquid form.

4. The composition of claim 1 wherein the crosslinking agent is water soluble and relatively low in molecular weight as compared to the polymer.

5. The composition of claim 1 further comprising:

an acid or acid-forming catalyst agent used for enhancing the crosslinking between the polyfunctional crosslinking agent and functional groups.

6. The composition of claim 1 wherein the polyfunctional crosslinking agent crosslinks by purely ionic means through salt bridges formed between protonated nitrogen

atoms of the crosslinking agent and anionic carboxyl and/or hyroxyl functionalities of the polymer.

7. The composition of claim 1 wherein the polyfunctional crosslinking agent crosslinks with itself via ring opening and polymerization to form higher molecular weight polyamines which can also crosslink by ionic means.

8. The composition of claim 1 wherein the polyfunctional crosslinking agent covalently crosslinks anionic carboxyl and/or hyroxyl functionalities of the polymer and the coreactant polyelectrolyte to form a three dimensional crosslinked network in the rubber by bridging polymer and polyelectrolyte chains.

9. The composition of claim 1 wherein the polyfunctional crosslinking agent entangles and entraps the polymer and the coreactant polyelectrolyte as it polymerizes into higher molecular weight forms.

10. The composition of claim 1 wherein the crosslinked rubber latex composition is in the form of rubber gloves or condoms.

11. The composition of claim 1 wherein the polymer includes at least one of -OH, -SH, -NH, $-NH_2$, -COOH, $-SO_2NH_2$, $-CONH_2$, -Cl or -Br functional groups, while the coreactant polyelectrolyte contains at least one of -OH, -SH, -NH, $-NH_2$, -COOH, $-SO_2NH_2$, $-CONH_2$, -Cl or -Br functional groups, such that 100 parts by weight of the polymer are present per 1 to 30 parts by weight of the coreactant polyelectrolyte.

12. The composition of claim 11 wherein the polyfunctional crosslinking agent is capable of reacting with at least one of the -OH, -SH, -NH, $-NH_2$, -COOH, $-SO_2NH_2$, $-CONH_2$, -Cl or -Br functional groups present.

13. The composition of claim 1 wherein the coreactant polyelectrolyte is compounded with the polymer, such that 100 parts by weight of the polymer are present per 1 to 30 parts by weight of the coreactant polyelectrolyte.

14. The composition of claim 1 wherein the polyfunctional crosslinking agent is added to the compound, such that 0.1 to 10 parts by weight of the polymer are present.

15. The composition of claim 1 wherein the polymer is a synthetic polymer, which contains 1% to 20% by weight of the functional groups, and has a molecular weight above 200,000.

16. The composition of claim 1 wherein the coreactant polyelectrolyte is a synthetic polymer, which contains 1% to 50% by weight of the functional groups, and has a molecular weight of 1,000 to 200,000.

17. The composition of claim 1 wherein the polyfunctional crosslinking agent is a polyfunctional aziridine.

18. The composition of claim 1 wherein the polymer is in the form of an aqueous latex rubber comprising a synthetic rubber that has carboxyl and/or hydroxyl functional groups attached to a acrylonitrile butadiene polymer, a butadiene polymer, a chloroprene polymer, a polyurethane polymer, or a acrylonitrile butadiene polymer blend.

19. The composition of claim 1 wherein the coreactant polyelectrolyte comprises a carboxylated and/or hyroxylated styrene butadiene, butadiene, ethylene acrylic polyelectrolyte, or any other carboxylated and/or hydroxylated synthetic polyelectrolyte.

20. The composition of claim 1 wherein the compound to which the polyfunctional crosslinking agent is added further comprises one or more fillers, waxes, plasticizers, surfactants, soaps, antioxidants, and pigments.

21. The composition of claim 1 wherein the polyfunctional crosslinking agent is added to the compound 1 to 72 hours before use of the composition, and at a level of no more than about 10% by weight of the polymer to the compound.

22. The composition of claim 1 wherein the polyfunctional crosslinking agent is added 2 to 48 hours before use of the composition, and at a level of no more than about 0.1 to 5% by weight of the polymer to the compound.

23. The composition of claim 1 wherein the composition exhibits a tensile stress retention property of from about 10% to 70%, where the stress retention property is defined as the percentage retention of initial stress force after a predefined time period at 100% extension.

24. The composition of claim 23 wherein the predefined period is about 6 minutes.

25. A crosslinked rubber latex composition comprising:

a polymer containing units having at least one of carboxyl and hydroxyl functional groups;

a coreactant polyelectrolyte having a relatively low molecular weight compared to the polymer, and compounded with the polymer to form a compound, and containing units having at least one of carboxyl and hydroxyl functional groups; and

a polyfunctional crosslinking agent timely added to the compound, and capable of crosslinking with at least two of the carboxyl or hydroxyl functional groups, or at least one of the carboxyl functional groups and at least one of the hydroxyl functional groups at an ambient temperature between 70 °F (21.1 °C) and 119 °F (48.3 °C), thereby forming a crosslinked network in the rubber latex.

26. The composition of claim 25 further comprising:

an acid or acid-forming catalyst agent used for enhancing the crosslinking between the polyfunctional crosslinking agent and functional groups.

27. The composition of claim 25 wherein the polyfunctional crosslinking agent crosslinks by purely ionic means through salt bridges formed between protonated nitrogen atoms of the crosslinking agent and anionic carboxyl and/or hyroxyl functionalities of the polymer.

28. The composition of claim 25 wherein the polyfunctional crosslinking agent crosslinks with itself via ring opening and polymerization to form higher molecular weight polyamines which can also crosslink by ionic means.

29. The composition of claim 25 wherein the polyfunctional crosslinking agent covalently crosslinks anionic carboxyl and/or hyroxyl functionalities of the polymer and the coreactant polyelectrolyte to form a three dimensional crosslinked network to bridge the polymer and polyelectrolyte chains.

30. The composition of claim 25 wherein the polyfunctional crosslinking agent entangles and entraps the polymer and the coreactant polyelectrolyte as it polymerizes into higher molecular weight forms.

31. The composition of claim 25 wherein the polyfunctional crosslinking agent is added 2 to 48 hours before use of the composition, and at a level of no more than about 0.1 to 5% by weight of the polymer to the compound.

32. A method for dip-forming rubber products comprising:

compounding a solution, latex, or dispersion of rubber latex A that includes A1 and A2 with a crosslinking agent B to provide a rubber polymer latex dip-forming composition, wherein A1 is a polymer containing units having at least one of carboxyl and hydroxyl functional groups, and A2 is a coreactant polyelectrolyte having a low molecular weight relative to the polymer and containing units having at least one of carboxyl and hydroxyl functional groups, and B is a polyfunctional crosslinking agent capable of crosslinking with at least two of the carboxyl or hydroxyl functional groups, or at least one of the carboxyl functional groups and at least one of the hydroxyl functional groups at ambient temperature or higher;

dipping a dip former in the rubber polymer latex dip-forming composition, and withdrawing the dip former, thereby providing a dip-formed wet latex gel layer; and

curing the dip-formed wet latex gel layer at ambient temperature or higher, so as to allow a crosslinking network to form, and to provide a dip-formed dry latex layer.

33. The method of claim 32 wherein prior to dipping the dip former in the rubber polymer latex dip-forming composition, the method further comprises:

coating a dip former with a chemical coagulant for latex.

34. The method of claim 33 wherein the chemical coagulant contains an acid or acid-forming catalyst to enhance crosslinking.

35. The method of claim 32 wherein prior to curing, the method further comprises:

dipping the dip-formed wet latex gel layer in a water bath to remove water-soluble impurities, wherein the water bath contains an acid or acid-forming catalyst to enhance crosslinking.

36. The method of claim 32 wherein prior to curing, the method further comprises at least one of:

coating the dip-formed wet latex gel layer with a liquid polymer, or chlorinating the dip-formed wet latex gel layer in a chlorine bath, to reduce the film surface tack, wherein the liquid polymer and/or the chlorine bath contains an acid or acid-forming catalyst to enhance crosslinking.

37. The method of claim 32 wherein curing the dip-formed wet latex gel layer is carried out in a temperature range from 70 °F (21.1 °C) to 119 °F (48.3 °C).

38. The method of claim 37 wherein curing time is about 30 minutes to an hour.

39. The method of claim 32 wherein curing the dip-formed wet latex gel layer is carried out in a temperature greater than 119 °F (48.3 °C)to provide a faster curing time relative to ambient temperature curing.

40. The method of claim 32 wherein the dip former is adapted to form at least one of condoms or protective gloves for medical, non-medical, scientific, and industrial uses.

41. The method of claim 32 wherein the rubber latex A further includes at least one of fillers, waxes, plasticizers, surfactants, soaps, antioxidants, and pigments.

42. The method of claim 32 wherein compounding the rubber latex A with the crosslinking agent B comprises:

adding the crosslinking agent B to the rubber latex A between 2 to 48 hours before use at a level of between about 0.1 to 5% by weight of component A1.

43. The method of claim 32 wherein curing the dip-formed wet latex gel layer further comprises:

evaporating excess water from the dip-formed wet latex gel layer.

44. The method of claim 32 wherein after curing the dip-formed wet latex gel layer, the method further comprises:

post-leaching the dip-formed dry latex layer in a water bath to remove water-soluble impurities, wherein the water bath contains at least one of an acid or acid-forming catalyst to enhance latent crosslinking, and a chlorine solution to reduce the surface tack on the rubber film.

45. The method of claim 44 further comprising:

evaporating excess water from the dip-formed dry latex layer.

46. A crosslinked rubber latex product comprising:

a polymer containing units having at least one of carboxyl and hydroxyl functional groups;

a coreactant polyelectrolyte having a relatively low molecular weight compared to the polymer, and compounded with the polymer to form a compound, and

containing units having at least one of carboxyl and hydroxyl functional groups; and

a polyfunctional crosslinking agent timely added to the compound, and capable of crosslinking with at least two of the carboxyl or hydroxyl functional groups, or at least one of the carboxyl functional groups and at least one of the hydroxyl functional groups at ambient temperature or higher, thereby forming a crosslinked network in the rubber latex product.

47. The crosslinked rubber latex product of claim 46 wherein the product has at least one of the following characteristics: a tensile stress modulus at 500% extension of not greater than 10 MPa, a tensile strength of greater than 14 MPa, and a tensile stress retention of less than 70% where the stress retention property is defined as the percentage retention of initial stress force after a 6 minute time period at 100% extension.

48. The crosslinked rubber latex product of claim 46 wherein the product is a condom.

49. The crosslinked rubber latex product of claim 46 wherein the product is a glove.

50. The crosslinked rubber latex product of claim 46 wherein the product is accelerator free.